

STATE ENGINEERING EXPERIMENT STATION

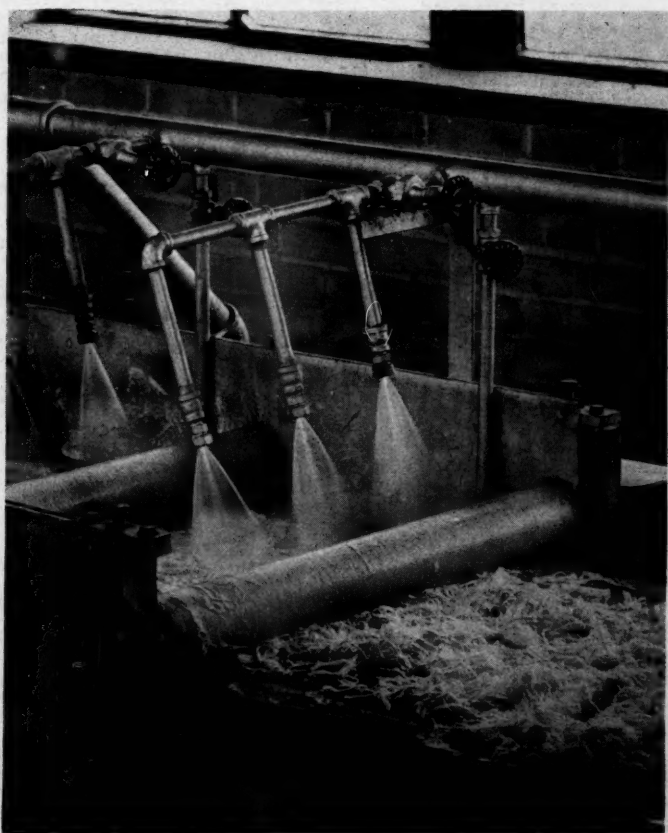
The Research Engineer

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TEXTILE RESEARCH

The importance of the textile industry to Georgia and to the South is such that no statistics are required to prove it. Because of a beneficial combination of raw material availability and the possession of an adequate labor force, the Southern states, in recent years, have continued to attract textile industries from other regions and to provide sites for entirely new factories, both for the production of raw materials and finished textile products.

It is little wonder, then, that this region is vitally concerned with textile research—with efforts toward continued progress and the solution of problems. As Dr. J. L. Taylor pointed out in his

recent Sigma Xi Award Address, printed in its entirety in this issue, there was a time when the textile industry itself held research of little import, but that time is long since past, buried in a flood of new fibers, new finishing agents, new dyes, new textile machinery, and changing market demands.

Dr. Taylor has summarized, in his article, several of the more important textile research studies which have been made here at Georgia Tech, chiefly in the laboratories of the Engineering Experiment Station and the School of Textile Engineering. Further details would add but little; however, it is not redundant to point out that Georgia Tech has been and will remain aware of its responsibility to aid in the forwarding of research in the textile field. Facilities for such research have recently been increased by the construction of the new W. Harrison Hightower Textile Building, with its large laboratory section, and there seems no reason to doubt that what has been accomplished here in the past will be but a forerunner to future research achieve-

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"Preservation of the American way of living" is a catch-phrase much used today by men with vastly different viewpoints. To the "hide-bound" isolationist, it means the same as the prewar "America First"—nothing for any other country if it would deprive us of an iota of our well being. To the average citizen, it means defending our constitutional rights and privileges against the onslaughts of "isms", maintaining that atmosphere in which men are individuals instead of units of a state system. To the extreme radical, it means free license to advertise his beliefs without fear of the reprisal which the system he advocates would inflict.

To the scientist and engineer—assuming that this group also agrees with Mr. Average Citizen—the phrase "preservation of the American way of living" is a challenge to increased efforts to find new and better methods and products. To this group, particularly, the "American way" is not a static one; it is progressive. Our method of living has developed, not stood still. It is the outgrowth of the efforts of many men. "Preservation" of this mode of living, therefore, means preservation of a dynamic balance between the best elements of the present and what the future can bring if we strive our hardest.

BLAKE R. VAN LEER,
President, Georgia Institute of Technology

THE PLACE OF RESEARCH IN THE TEXTILE INDUSTRY

By JAMES L. TAYLOR*

In recognition of his research which led to the publication of a paper on "Ramie Today," Dr. James L. Taylor, last spring, received the 1949 Faculty Award of the Georgia Tech Sigma Xi Club. In addition to receiving a monetary award, the winner each year is privileged to address the faculty and friends of Georgia Tech on a subject of his own choice at a Sigma Xi public lecture held during commencement week ceremonies. Dr. Taylor chose as his subject "The Place of Research in the Textile Industry," a subject on which he is well qualified to comment.

Not so long ago, to associate the term *research* with that of *textiles* was almost like putting new wine into old bottles. Even today, some phases of the textile industry look with suspicion on research and think of it as a luxury and not a necessity for future development. However, thanks to the growing cooperative spirit between many research directors and management personnel, this condition is fast disappearing.

*Professor of Textile Engineering.

The term "research" has everywhere become exceedingly popular in the last decade and has probably been greatly overused. Similarly, the highly scientific developments which were brought to our attention during the World War II are largely responsible for the wide usage of certain terms which were almost foreign to the average person a few years ago. In the textile industry, for example, we have become accustomed almost overnight to the use of

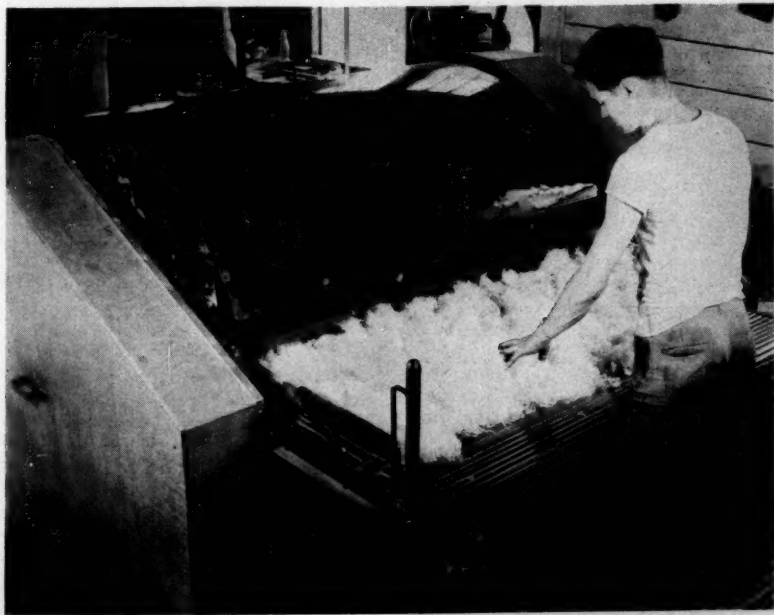


Figure 1. Feeding degummed, fluffed ramie fibers into a Garnett card.

such terms as superpolymers, synthetics, plastics, resins, etc. Webster defines "research" as "a careful search" or critical investigation aimed at revising accepted conclusions in the light of newly discovered facts. C. F. Kettering, research consultant for the General Motors Company, once defined research as "an effort to do things better and not be caught asleep at the switch."

Regardless of the exact definition of the term, we should not be confused with what we see and read nor lose sight of the objectives of research. In this connection one might recall the story of the Englishman who criticized American cocktails. He said, "You put in whiskey to make it strong, soda to make it weak, bitters to make it hot, ice to make it cold, a piece of lemon to make it sour, a dash of sugar to make it sweet—then say, 'Here's to you' and drink it yourself." At times the layman thinks that the research worker is just as confused. He removes scales from wool fibers to make them smooth, then tries to put them on rayon to make it rough. He works nights to produce stronger synthetic fibers and the next day develops one that dissolves in water. He strives to impart permanent crimp to rayon fibers, then evolves a method to take kinks out of hair. He adds chemicals to fabrics to make them water-repellent, and then treats cotton to make it absorb more water.

TEXTILE HISTORY

The textile industry is one of the oldest and greatest industries in the world. It was born by man's genius and inventiveness, as part of his struggle for survival. Some 10,000 years ago, man realized that he could protect himself from the beasts by building stockades of poles and intertwining vines through them for strength. He learned to make a litter and bed by a similar interlacing of vines, then learned to use such softer fibers as wool and retted flax.

During the Pastoral Age, about 3000 B.C., it became socially proper to wear clothing. The art of spinning became highly developed, and it has been reliably reported that gossamer-like fabrics were made with such fine texture that they were almost invisible when wet. Swiss Lake dwellers wove delicate and colorful patterns into fabrics, and

Egyptians produced much fine muslin in which to wrap their dead—all before the year 1 A. D.

The growth of the textile industry has been very closely related to the Industrial Revolution, which was a fundamental change or series of changes in the methods of producing cloth, iron, steel and many other manufactured goods during the latter part of the 18th and most of the 19th Centuries. The cotton gin, spinning jenny, the flying shuttle, the water frame, the power loom, and many machines which replaced hand labor were history-making inventions which brought about revolutionary changes in the homes and lives of the families which worked as spinners, weavers, and dyers. Before the age of these machines, most textile processing was conducted in homes, as family projects. The inventions of these machines, however, almost immediately caused the building of factories and textile mills, whereupon the textile industry changed from community family units to one of workers laboring under one roof, with close supervision over the various phases of the processing.

By the beginning of the 19th Century, the mechanical side of the textile industry had been almost completely revolutionized. Today, it leads all others in the number of persons employed and ranks fourth as regards its value of products, outranked only by the foodstuffs, steel, and automobile industries. The livelihood of 13,000,000 persons is dependent on cotton alone. There are 6,500 textile mills in the United States. Some 20,000 companies are converting cloth into wearing apparel.

RESEARCH BEGINNINGS

Planned textile research is something new and belongs to the 20th Century. The first steps in industrial research were made when men were occasionally called in to assist in the solution of problems confronting the rapidly growing industries. However, many years elapsed from the time of spasmodic appeals made to individual scientists to that of the setting up of laboratories organized specifically to carry out industrial research. By the end of the last century, how-

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TELEVISION REPRODUCTION BY VELOCITY MODULATION

By M. A. HONNELL* and M. D. PRINCE**

A reduction in the cost of television systems will result in wider use of television for special industrial and military purposes. The velocity-modulation television reproduction technique described in the following paper may permit a simplification in television equipment for certain applications where the loss in tonal values is acceptable. The research study reported here was conducted under the sponsorship of the Georgia Tech Engineering Experiment Station.

In standard television systems, pictures are reproduced on the cathode-ray tube, or kinescope, by varying the brightness of a spot which moves in synchronization with a spot that is scanning the picture on the mosaic of the television pickup tube. At all times, this latter spot moves with a constant horizontal velocity along the line being scanned.

Another method of television reproduction which is not so well known employs a velocity modulation principle.² In this

method of picture transmission, the brightness of the spot is maintained constant, and the change in brightness of the reproduced picture is achieved by varying the horizontal velocity of the spot in both the kinescope and camera tube in accordance with the brightness of the picture on the mosaic of the camera tube. Bright portions of the picture are reproduced by a low spot velocity, and dark portions are reproduced by a high spot velocity.

During the course of an investigation conducted at Georgia Tech on the resolution characteristics of a military airborne

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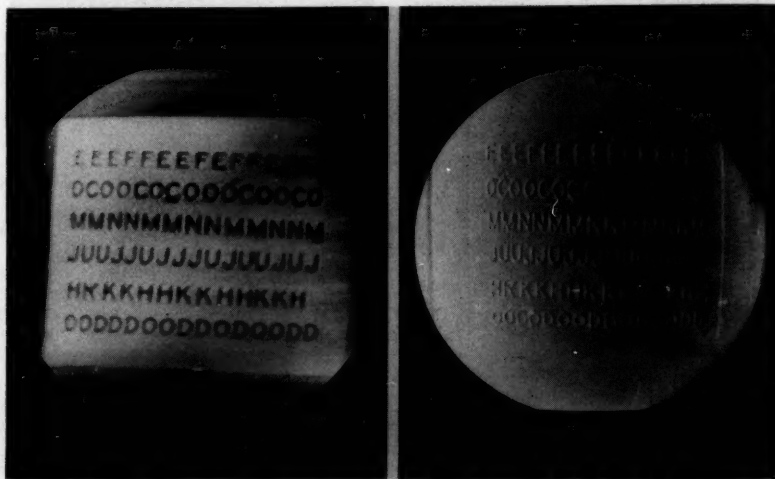


Figure 1. A television test chart reproduced by standard (left) and VTR (right) principles.

television system, it was found possible to reproduce an image from a conventional video signal by use of a modification of this velocity modulation principle.¹ Although velocity modulation has several disadvantages insofar as commercial entertainment-quality television is concerned, this adaptation has some features which may make it desirable for special purpose video applications.

In this composite system, the picture to be transmitted is scanned with constant velocity and the resulting signal is amplified in the usual manner, while the image is reproduced by varying the horizontal velocity of the spot on the screen of the kinescope. The variation of deflection velocity is achieved by superimposing the video signal on the horizontal kinescope deflection voltage. While this hybrid system of velocity television reproduction (which will henceforth be called the VTR system in this paper) lacks the fine contrast gradation available in standard television systems, it does give good detail in the reproduction of printed matter or line drawings.

REPRODUCTION OF SILHOUETTE-TYPE SUBJECT MATTER

Subject matter which has "high contrast" comprises an important class of material that can be reproduced with good detail by VTR. This category includes printed material, maps, line drawings, and circuit diagrams. A comparison of velocity television reproduction and standard television reproduction of silhouette-type subject matter is illustrated in Figure 1, while a standard television test pattern reproduced by VTR is shown in Figure 2 to illustrate further the detail attainable with this system. The figures shown were reproduced on a five-inch cathode-ray tube and were photographed on 35-mm. film. Some detail necessarily was lost in the photographic and printing processes.

VTR results in the outlining of two-tone objects by a light band on the left side and a dark band on the right. Only the outline of the televised object is visible. When a narrow line is reproduced, the dark and bright bands lie very close together, thus giving maximum contrast and visibility.

The relative positions of these bands can be interchanged by reversing the polarity of the injected video signal. The general appearance of the reproduced image suggests a three-dimensional effect corresponding to a light and shadow outline of the object.

EXPERIMENTAL APPARATUS

The experimental phase of this research was carried out using a military television camera connected directly to a monitor by coaxial cable with no intervening radio-frequency sections. This system utilized sequential scanning of 350 lines per frame, 40 frames per second, and had a video bandwidth of approximately 2.5 megacycles. The kinescope scanning voltages were generated and amplified by the monitor, and were synchronized with the camera scanning signals.

In this arrangement, a small portion of the generated video signal was introduced into the monitor horizontal deflection circuit immediately preceding the horizontal deflection amplifier. The horizontal amplifier

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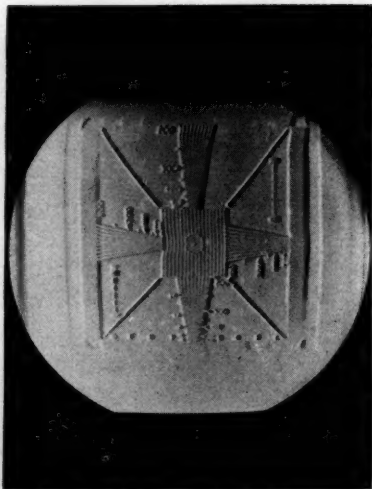


Figure 2. A television resolution pattern reproduced by VTR.

THE SEPARATION OF RARE EARTH ELEMENTS, PARTICULARLY PRASEODYMIUM AND NEODYMIUM

By W. T. ZIEGLER*

Because of the infrequency of their commercial use, the rare earth elements have long remained relatively unexplored when compared with other elements. One of the reasons why they have been little used and studied is their similar chemical properties, which until recently has made their separation extremely difficult. Now, however, these elements are proving of considerable interest, because of more rapid methods of separation and because of their occurrence as products of the fission of uranium-235. The following article briefly surveys the subject of the rare earths and their separation, and describes Georgia Tech research on the separation of neodymium, praseodymium, and lanthanum.

During the past several years, a program of research directed toward the study of the properties of matter at very low temperatures has been under way at Georgia Tech. One of the objectives of this program** has been the study of the electrical and magnetic properties of the rare earth metals and certain of their compounds, with particular emphasis on the possible occurrence of superconductivity*** in these materials. Interest in these metals and compounds has stemmed from several facts, among which are (1) the known occurrence of superconductivity in lanthanum, (2) the absence of any similar studies on the remaining 14 closely related rare earth metals, (3) the known occurrence of lanthanum and several other of these metals in two or more crystalline modifications, and (4) the apparent non-salt-like character of the hydrides and nitrides of these metals.

The performance of such studies of the rare earth metals and compounds presupposes the availability of these materials, either from commercial sources or as a result of preparation in the laboratory. While some of these materials can be purchased in a fairly high state of purity, most of them

cannot. Therefore, considerable effort has been devoted to the analysis of available rare earth materials and the preparation of pure oxides from which the desired metals and compounds can be prepared. It is the purpose of this paper briefly to review some of the methods of separating the rare earth elements from each other and to describe some of the results obtained in the separation of certain of these materials by the relatively new technique of ion exchange.

RARE EARTH ELEMENTS

The 15 elements which have atomic numbers 57 through 71 are generally referred to as the rare earth elements.¹ These elements are, in order of increasing atomic number, lanthanum, cerium, praseodymium, neodymium, "element 61," samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium. Historically, the name "rare earth" arose from the supposed rarity of their occurrence in the earth's crust, although in actual fact some of them, notably cerium, are about as plentiful as tin and tungsten.

These elements, together with the elements yttrium and scandium, all exhibit chemical properties so similar in most respects that their separation from each other has proved to be, until recently, an extremely difficult problem. The preparation of pure compounds has been further com-

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**This work is being carried out with the assistance of the Office of Naval Research under Contract N6-ori-192.

***The occurrence of superconductivity in a metal or compound is characterized by the sudden disappearance of electrical resistance and the appearance of zero permeability to a magnetic field.

plicated by the fact that the minerals which must be used as starting materials usually contain several of the rare earth elements, making such separation a necessity.

The rare earths are frequently divided roughly into two groups—the cerium group and the yttrium group. The cerium group includes the elements La, Ce, Pr, Nd, Sm, and Eu; the yttrium group includes Y, Gd, Tb, Dy, Ho, Tm, Yb, and Lu. Europium and scandium are sometimes included in the yttrium group. This division, which is by no means sharp, is based largely upon a rough quantitative difference in behavior. For example, the sulfates of the yttrium group are considerably more soluble in potassium or sodium sulfate solutions than are the sulfates of the cerium group.

Until recently, the principal method of rare earth separation which has been employed is that of fractional crystallization. This method is based on small differences in the solubilities of the same compound of the different rare earths. Thus, the magnesium double nitrate, $2R(NO_3)_3 \cdot 3Mg(NO_3)_2$ (where R = trivalent rare earth ion), has been widely utilized to achieve separation of the members of the cerium group from each other. This method, while effective, is very time consuming in practice, since many recrystallizations must be carried out before pure products are obtained.

Certain of the rare earths can exist in more than one valence state. Thus, samarium, europium, and ytterbium can be obtained in a moderately stable bipovalent state, as well as the usual tripositive state. This difference in valence state has been utilized in separating these elements from rare earths which cannot be reduced to the bivalent state.

It has been shown by Appleton and Selwood³ that the distribution ratio between *n*-butyl alcohol and water is different for neodymium and lanthanum thiocyanates. The ratio of the neodymium to lanthanum in the alcohol layer was found to be 1.06. Later experiments with the nitrates of these elements by Templeton and Peterson⁴ employing *n*-hexyl alcohol and water have indicated that a separation factor of approximately 1.5 can be attained. Templeton⁴ also has found that in this two-phase system the distribution ratio of lanthanum, cerium

(ous), praseodymium, neodymium, and samarium nitrates are significantly different from one another. These observations suggest a basis upon which a successful method for the automatic countercurrent extraction of the rare earths might be developed.

During the past nine years, interest in the chemistry of the rare earth elements has increased tremendously as a result of the discovery that many of the rare earth elements are identifiable among the products of the fission of uranium-235. This discovery lent impetus to the search for separation methods of greater selectivity and speed than those which had previously been employed. As a result of intensive research on the Manhattan Project, during and immediately following the war, a method of separating the rare earths was developed which utilizes the ion exchange properties of synthetic resins, together with the complex-forming properties of the trivalent rare earth ions.^{5, 6}

SEPARATION OF RARE EARTHS BY ION EXCHANGE*

The method used for the separation of rare earths by means of ion exchange resins may be outlined briefly by referring to Figure 1, which is a schematic diagram of the apparatus used for this purpose in the Georgia Tech Low Temperature Research Laboratory. The essential features of this apparatus are identical with those used by other investigators. The apparatus consists of a cylindrical pyrex glass tube, *A*, in which the resin bed, *B*, is supported at *F* by a fritted glass plate. The resin employed, which has been "conditioned" so as to remove all interfering substances, is in a wet form and covered by a layer of liquid, *H* (usually distilled water). A solution of the chlorides of the rare earths, approximately 0.2 M in HCl, is added to the top of the column and the solution allowed to flow through slowly by controlling the setting of a pinch clamp at *C2*. In this process, the rare earth ions are quantitatively adsorbed onto the resin. The actual separation process is then begun by passing the complex-forming solution from the reservoir, *E*,

*The material of this section unless otherwise stated is based largely upon the papers included in the symposium referred to in Reference 6.

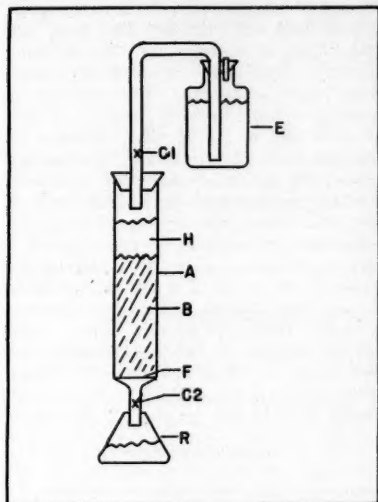


Figure 1. Ion exchange resin column used in separating rare earths.

through the column at a slow rate, the flow being adjusted by controlling the setting of the pinch clamps at C1 and C2. The effluent solution is caught in various fractions at R and the fractions analyzed.

It has been shown experimentally that, in general, the rare earths appear in the effluent fractions in their order of decreasing atomic number when ammonia-citric acid mixtures of controlled pH are used as the eluting solution. Furthermore, under optimum conditions, complete separation of mixtures containing certain of the rare earths may be achieved in one pass through a column.

Many factors combine to determine the optimum conditions for column operation.

Among these are (1) nature and particle size of the resin employed, (2) the nature, concentration, and pH of the complexing agent, (3) the composition of the starting rare earth mixture, (4) the ratio of starting weight of oxide to cross-sectional area of the resin bed, (5) the geometry of the resin bed, (6) the flow rate of the eluting solution, and (7) the temperature. The

choice of optimum conditions for column operation is made, essentially, by balancing these factors, which determine optimum separation (i.e., longer columns, slower flow rates, small cation-to-resin ratios), against the desire for reasonable speed, yield, and economy of materials.

SOME EXPERIMENTS ON THE SEPARATION OF NEODYMIUM, PRASEODYMIUM, AND LANTHANUM

During the past year, a considerable number of experiments have been carried out at Georgia Tech with a view toward preparing moderate quantities (10-50 gm.) of praseodymium and neodymium oxides having a purity of 99.5 per cent or better, employing commercially available rare earth concentrates as starting materials. Some experiments on samarium have also been conducted. Certain of the experiments which have been performed on the separation of praseodymium from neodymium and lanthanum will be described briefly as an illustration of the method of separating these rare earths by ion exchange resins.*

The choice of the conditions employed for carrying out these separations was based, in part, upon the results obtained by Spedding and his co-workers,^{7, 8, 11} using the Amberlite resins, and upon the results of Harris and Tompkins,¹⁰ using the resin Dowex-50. Spedding and his co-workers,¹¹ in particular, have reported separations of these rare earths on a multi-gram scale.

An effort was made in the present work to achieve moderately good separation of fairly large amounts of neodymium and praseodymium fairly rapidly by a single pass through a column, followed by a purification of the praseodymium oxide so obtained in a second column under conditions likely to give better separation of these elements. The work of Harris and Tompkins¹⁰ was particularly helpful in determining the choice of these conditions.

The synthetic resin Dowex-50** was employed as the ion exchange resin in the present work. This resin was chosen because

*A brief report of this work was presented before the Georgia Academy of Science, April 23, 1949.

**Supplied by courtesy of Dr. W. C. Baumann of the Dow Chemical Company, Midland, Michigan.

of its high exchange capacity. Citric acid solutions, the pH of which had been adjusted to the desired value by the addition of 15 M NH_4OH , were used as the complexing agent. All pH measurements were made with a Beckman Model G pH meter, sensitive to ± 0.02 pH units. One tenth of one per cent of phenol was added to the citric acid solutions to prevent mold formation.¹²

Figure 2 shows the results of an experiment (designated as Run No. 3) carried out to separate praseodymium from a starting material consisting of 20.00 gm. of an oxide* having the composition 9.0 per cent Nd_2O_3 and 42.7 per cent Pr_2O_3 , the remainder being primarily La_2O_3 . A spectrophotometric study showed no absorption bands

for any of the other rare earths in the range 380 to 1000 millimicrons. The resin bed was 4.7 cm. in diameter and 73.5 cm. long. The resin, which was received in the sodium form, was "conditioned" prior to use by soaking in two successive portions (a total of 1700 ml.) of 1.4 M HCl, followed by washing with distilled water. Subsequent experience indicated that this treatment probably converted the resin only partly to the acid form. The starting material was added to the column in the form of a chloride solution, made by dissolving the oxides in 30 ml. of 12 M HCl and diluting to one liter. Elution was carried out using a "4.4%" citric acid solution, made by dissolving 800 gm. of citric acid monohydrate and 18 gm. of phenol in 18 liters of distilled water and adjusting the pH to 3.17 by means of 15 M NH_3 solution. This solution

*This oxide was prepared from a special grade of praseodymium ammonium nitrate obtained from Lindsay Light and Chemical Company, West Chicago, Illinois.

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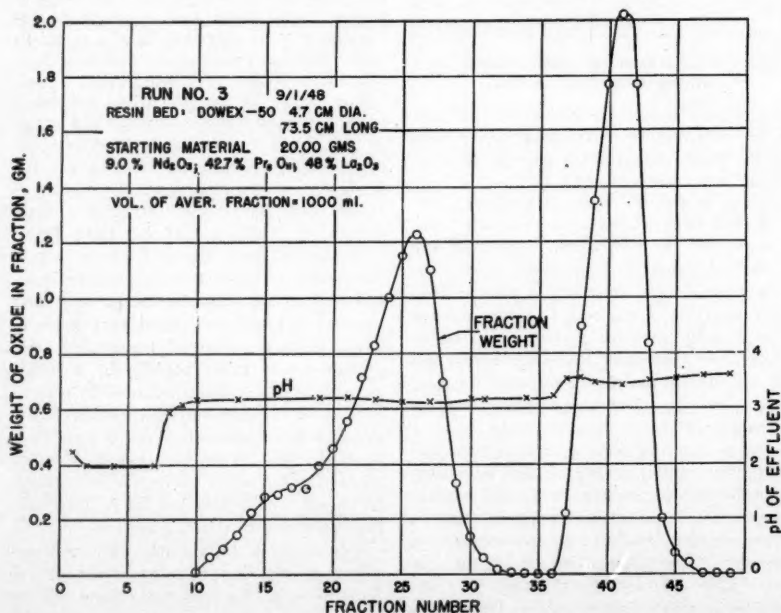


Figure 2. Data from the ion exchange separation of praseodymium from 20 grams of an oxide containing 9.0 per cent Nd_2O_3 , 42.7 per cent Pr_2O_3 , and the remainder primarily La_2O_3 .

DIGESTS OF GRADUATE THESES
CHEMICAL ENGINEERING AND CHEMISTRY
1948-1949

The following digests represent summaries of theses submitted during 1948-49 in partial fulfillment of the requirements for the degrees of Master of Science in Chemical Engineering and Master of Science in Chemistry. This is the second in a series of features designed to present data on the graduate theses submitted last year to the various schools of the Georgia Institute of Technology.

CHEMICAL ENGINEERING

Roy West Darwin, Jr., *The Adsorption of Fatty Acids on Carbon Black*. Faculty advisor: Dr. J. W. Mason.

The rubber industry, for many years, has been interested in the action of "fillers" in rubber compounds. Since carbon black is by far the most widely used of these fillers, knowledge of the chemical and physical forces existing between carbon black particles and rubber molecules is of the greatest importance in the production of a product having certain desired characteristics. To study these forces, simple adsorption systems have been investigated using carbon black as the solid phase.

The purpose of this investigation was to determine the effect of the degree of unsaturation of the adsorbate and the chemical and physical properties of the adsorbent surface on the adsorption isotherms. For this purpose, three fatty acids of equal chain length but of varying degree of unsaturation were adsorbed from hexane solutions on four different carbon black surfaces. It was found from this study that devolatilized carbon surfaces adsorbed larger amounts of all three acids than did oxidized surfaces, while untreated carbon blacks varied widely in their adsorption of the three acids. The saturated acid was found to obey Langmuir's adsorption isotherm, whereas the unsaturated acids followed more nearly the Freundlich relation. The forces of attraction between the carbon surfaces and the acids become more pronounced as the degree of unsaturation of the latter is increased. A. S. C.

John Lewis Hancock, *Drying Characteristics of Ramie Fiber*. Faculty advisor: Dr. J. M. DallaValle.

The need for data on the drying of ramie fiber is becoming increasingly important as a result of recent success obtained from research on other phases of the processing of this fiber. It was the purpose of this investigation to obtain data that could be analyzed to determine the mechanism and characteristics of the drying of ramie fiber and fibers in general, and information that would be useful in designing drying equipment for these fibers. This was accomplished by checking existing equilibrium data on degummed garnetted ramie fiber and also by determining the drying mechanism and characteristics of this fiber.

This work indicated that the mechanism of drying of garnetted ramie fiber includes the moving of water up to the surface of the fiber by capillary action, where it is removed by evaporation at a rate determined by air velocity and other factors influencing the film characteristics. Details of the effect of different air velocities, variation of humidity, air pockets and nonuniform moisture distribution, influence of slab thickness, and change in drying rate with change in the dry density of the fiber are included in this thesis. A. S. C.

Seaborn Alton Newton, Jr., *Use of Treated Clays for Extinguishing Fires*. Faculty advisor: Dr. J. M. DallaValle.

In recent years, clays have been increasingly employed as carriers for insecticides, rug cleaners, etc. Since it seemed possible that a similar combination of clay and extinguishing substance might prove effective in combating fires, it was decided to conduct a thorough investigation of the adsorptive

and desorptive properties of various clays, of the best fire extinguishing substance to be adsorbed by the clay, of the quantities adsorbed without altering dispersal properties of the clay, of an effective method of dispersing the treated material, and of amounts required to extinguish various types of fires.

Desorption and bulking tests of the four clays studied, nearly corresponding to the four general subdivisions of clay formations, indicated the superiority of attaclay (a Fuller's earth) as an adsorbent carrier for carbon tetrachloride, the most efficient fire-extinguishing liquid for combination with the clays. A cloud of this mixture, whose limiting concentration of extinguisher was found to be 50 per cent, is apparently more effective when allowed to settle over a fire than when dispersed from an ejector. In the latter case, moreover, air is not suitable as a projection medium. Although a 50-gram mixture will completely extinguish a standard fire (that resulting from burning a square of packed excelsior, two feet on a side and three to five inches deep), determination of optimum quantities for different fires along with further details intrinsic to this new method constitute an important field for future study. *M. M.*

Toy Franklin Reid, Equilibrium Moisture and Drying Characteristics of Textile Fibers. Faculty advisor: Dr. J. W. Mason.

In view of the increased importance of ramie, this study was undertaken to fill the need for data that would permit design calculations of dryers for ramie fibers. Data were obtained for decorticated ramie, degummed ramie, degummed opened ramie, and raw cotton. The theory of drying was particularly considered in regard to bringing moisture to the surface of the stock to be dried. Determination of the equilibrium moisture content as a function of per cent relative humidity and study of drying characteristics of decorticated and degummed ramie under various conditions constituted the major portion of this investigation.

Graphed results show the hysteresis effect exhibited by decorticated and degummed ramie fibers to be most pronounced at low temperatures and high humidities. Because of the presence of water-soluble materials

in the raw fiber, the equilibrium moisture content of decorticated ramie is usually at least 60 per cent higher than that of degummed ramie, which in turn surpasses that of the opened ramie. The undegummed cotton has a slightly higher equilibrium moisture content than does the opened, degummed ramie. *M. M.*

Floyd Delma Richards, The Construction and Testing of a High Temperature Adiabatic Calorimeter. Faculty advisor: Dr. W. T. Ziegler.

Equations have been derived elsewhere by which the mean specific heat of a substance and, consequently, other specific heat data can be determined when a finite quantity of heat added causes a finite temperature rise. Since such data are important in the calculation of heats of reaction, free energy changes, and various relations between thermodynamic functions, the ability to measure the exact quantity of heat added to a substance is an evident necessity. The adiabatic calorimeter, which functions on the principle that there will be no net change of heat between two bodies at the same temperature, is known to yield the most accurate measurements, and this study is concerned with the construction and testing of a type of adiabatic calorimeter designed by Dr. W. T. Ziegler.

Completed in June, 1946, Dr. Ziegler's design, which incorporates the most desirable features of preceding apparatus, was considered in this program under three headings: calorimeter assembly and vacuum and electrical controls. The normal temperature range for the determination of specific heats and heats of transition of solids and liquids is 20-150° C., but lower temperatures may be employed without difficulty in this adiabatic calorimeter. Considering the small heat losses encountered in tests and the wide range of temperatures which may be employed, it was evident that the design and construction were successful, although some improvements were suggested. *M. M.*

Russell Irwin Tarver, Purification of Scandium Using an Ion Exchange Resin. Faculty advisor: Dr. W. T. Ziegler.

Because known processes for the separation of scandium from thorium were both time

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REPORT FROM THE LIBRARY

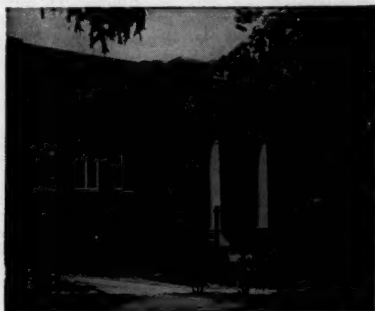
By DOROTHY M. CROSLAND*

Textile research and education depend for their basic information on the published results of earlier experiments and tests. To render effective the textile program of the Georgia Institute of Technology, the library has concentrated on the collection of specific textile literature and the provision of books and journals in the broad field of science and engineering upon which textile technology is based. This collection is described in the following article.

When this issue of THE RESEARCH ENGINEER comes from the press, the new Hightower Building, housing the A. French Textile School, will have opened its doors to students and faculty. In the northeast corner of the administrative part of this building is a small library, beautifully finished in mahogany. The room is well lighted and air conditioned. Books and periodicals that pertain purely to textile subjects will be housed in this Textile Library. However, indexes, abstract journals, and reference books that cover other related scientific and technical subjects are kept in the central library, where literature searching is usually conducted.

We are attempting to make the Textile Library as complete as possible. Its resources will be available for consultation to all textile men in Georgia, although books may be borrowed only by students and faculty members. Reference books and periodicals may not be circulated, however, and must not be taken from this library. As there are seats for only 14 persons, the Textile Library will be used only for reference work and not for general study. The Textile School's secretary and a student assistant will be in charge of the collection.

The Georgia Tech Library is the national depository for Farmington Plan books in the field of the textile industries. The Farmington Plan was devised in order that libraries having research collections might join in the cooperative acquisition of foreign publications of interest to research workers in various fields. Each item so acquired is promptly catalogued and listed in the Union Catalog at the Library of Congress, making the materials collected from



all over the world available to American research workers. On the nationwide basis of this plan, Georgia Tech was fortunate enough to be assigned the textile industries because of its existing collection of books and periodicals in the textile field. We have received the following items on the Farmington Plan:

Annuaire-Guide du Caoutchouc, des Matieres Plastiques, et des Isolants. Oliver Lesourd, Paris, 1948.

Boucier, P. G., *Le Genet: Textile Nouveau. Ses Origines, les Phases de se Developpement, Ses Possibilites D'Avenir.* Fontenay-aux-Roses, Seine, 1948.

Champetier, M. G., *Les Polyamides et le Nylon.* Univ. de Paris, Paris, 1948.

Champion, Jean, *Analyses de L'Etrage en Filature.* Les Editions de L'Industrie Textile, Paris, 1948.

La Condition Publique des Soies de Lyon. Administree par la Chambre de Commerce de Lyon. A. Rey, Lyon, 1948.

Congres International de la Soie, Volume 2. Lyon-Paris, 1948.

Diserens, L., *Neueste Forschritte und Verfahren in der Chemischen Technologie der Textilfasern.* Birkhauser, Basel, 1949. 2v.

Fierz-David, H. E. und Merian, E., *Abriass der Chemischen Technologie der Textilfasern.* Birkhauser, Basel, 1948.

Gilonne, Georges, *Soieries de Lyon.* Editions du Fleuve, Lyon, 1948. 2v.

Dans Handweben. Kleine Anleitung fur Schule und Haus. Muller, Werder, Zurich, 1948.

*Librarian, Georgia Institute of Technology.

- Jungblut, Albert et Huleux, Marcel, *Les Machines a Tricoter Rectilignes a Main et Automatique*. Editions "La Maille", 3d ed., Paris, 1948.
- Lambrette, A. *Les Appareils Textiles*. Editions Textile et Technique, 2d ed., Paris, 1948. 3v.
- Pinon, Alexis, *Glossaire Technologique se Rapportant Plus Specialement aux Tissus D'Exportation et aux Industries Textiles et Connexes, Complete de Renseignements Divers*. Parc Saint-Maur, 2d ed., Seine, 1948.
- Prelese, Giuseppe, *Sbianca e Tentura Della Fibra Tessili Stampa dei Tessuti*. U. Hoepli, 2d ed., Milano, 1949.
- Villard, C., *Manuel de Theorie du Tissage*. A. Rey, 3d ed., Lyon, 1948. 2v.

The Textile Library currently receives, either by subscription or gift, 64 textile periodicals from all over the world. We have back files of many of these journals; some day we hope to have complete files of all or most of them. The following are the periodicals in the textile field which are currently received:

- American Association of Textile Technologists*. Papers. New York, New York
- American Dyestuff Reporter*. New York, New York
- American Fabrics*. New York, New York
- American Wool and Cotton Reporter*. Boston, Massachusetts
- Apparel Arts*. Chicago, Illinois
- British Rayon and Silk Journal*. Manchester, England (formerly *Silk Journal and Rayon World*)
- Canadian Textile Journal*. Montreal, Canada
- Ciba Revue*. Basel, Switzerland
- Coton et Fibres Tropicales*. Paris, France
- Cotton Textile Hi-Lights*. New York, New York
- Daily News Record*. New York, New York
- Cotton Trade Journal*. Memphis, Tennessee
- DuPont Magazine*. Wilmington, Delaware
- The Dyer*. London, England
- Dyestuffs*. New York, New York
- Egyptian Cotton Gazette*. Alexandria, Egypt
- Empire Cotton Growing Review*. London, England
- Fibres*. London, England
- Fibres, Fabrics and Cordage*. (Irish) Belfast, Ireland
- Hosiery Times*. Leicester, England
- Indian Textile Journal*. Bombay, India
- L'Industrie Textile*. Paris, France
- L'Institut Textile de France*. Bulletin. Paris, France
- Institute of Textile Technology*. News Letter. Charlottesville, Virginia
- Journal des Textiles*. Paris, France
- The Knitter*. Charlotte, North Carolina
- Lowell Textile Institute*. Bulletin. Lowell, Massachusetts
- Melliand Textilberichte*. Mannheim, Germany
- Men's Wear*. New York, New York
- Monsanto Magazine*. St. Louis, Missouri
- Rayon and Synthetic Textiles*. New York, New York (formerly *Rayon Textile Monthly*)
- Rayon Organon*. New York, New York
- Rayon Yarns*. Old Hickory, Tennessee
- Revista Textil*. Buenos Aires, Argentina
- Revue Textile*. Paris, France
- Rohm & Haas Reporter*. Philadelphia, Pennsylvania
- Silk and Rayon*. Manchester, England
- Society of Dyers and Colourists*. Journal. Leeds, England
- Southern Textile News*. Charlotte, North Carolina
- Teintex: Revue Generale des Matieres Colorantes*. Paris, France
- Tekstil'naya Promyshlennost*. Moscow, USSR
- Textielwezen*. Ghent, Belgium
- Textil-Rundschaу*. St. Gallen, Switzerland
- Textil-Zeitung* (8 supplement, *Illustrierte Textil-Zeitung*). Mainz, Germany

- Textile Bulletin*. Charlotte, North Carolina
- Textile Colourist and Converter*. New York, New York
- Textile Forum*. Raleigh, North Carolina
- Textile Industries* (formerly *Cotton*). Atlanta, Georgia
- Textile Institute Journal*. Manchester, England
- Textile Institute*. Transactions. Manchester, England
- Textile Journal of Australia*. Melbourne, Australia
- Textile Manufacturer*. Manchester, England
- Textile Mercury and Argus*. Manchester, England
- Textile Recorder*. Manchester, England
- Textile Research Journal*. New York, New York
- Textile Research Journal*. Abstracts. New York, New York
- Textile Technology Digest*. Charlottesville, Virginia
- Textile Weekly*. Manchester, England
- Textile World*. New York, New York
- Textiles Panamericanas*. New York, New York
- Textiles Suisses*. Zurich, Switzerland
- Whitin Review*. Whitinville, Massachusetts
- Wool Digest*. New York, New York
- Wool Record and Textile World*. Bradford, England

These journals are supplemented by the more than 1,900 received in the central library. For example, chemistry journals and abstracts are part of the central collection. Moreover, the following indexes and abstract journals useful to textile research are located in the central library:

- Abridged Patent Specifications*. Great Britain Patent Office, London, 1855.
- Agricultural Index*. Cumulative. H. W. Wilson Co., New York, 1922.
- Australian Official Journal of Patents, Trademarks and Designs*. Department of Patents, Canberra, Australia, 1949.
- British Abstracts*. Bureau of Abstracts, London, 1847.
- Chemical Abstracts*. American Chemical Society, Washington, D. C., 1907.
- Chemical Industries*. MacLean-Hunter Publishing Corporation, Philadelphia, 1930. (contains abstracts of U. S. chemical patents).
- Chemisches Zentralblatt*. Akademie Verlag, Berlin, Germany, 1830.
- Engineering Index Service*. New York.
- Engineering Index*. New York, 1884.
- Experiment Station Record*. U. S. Office of Experiment Station, Washington, D. C., 1900-1946.
- Industrial Arts Index*. H. W. Wilson Co., New York, 1913.
- International Index to Periodicals*. H. W. Wilson Co., New York, 1946.
- Monthly Checklist of State Publications*. U. S. Government Printing Office, Washington, D. C., 1895.
- Natural and Synthetic Fibers Abstract Service*. Interscience Publishing Co., New York, 1944.
- New Technical Books*. New York Public Library, New York, 1933.
- Official Gazette of the United States Patent Office*. U. S. Government Printing Office, Washington, D. C., 1872.
- Patent Specifications*. U. S. Patent Office, Washington, D. C., 1946.
- Readers Guide to Periodical Literature*. H. W. Wilson Co., New York, 1900.
- Record and Registry of Trade Marks*. Canadian Patent Office, Ottawa, Canada, 1890.
- Science Abstracts*. Institute of Electrical Engineering, London, 1898.

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Technical Book Review Index. Special Libraries Association, New York, 1935.
Literature searches and bibliographies made from materials in the library collec-

tions are available through the Technical Information Division of the Georgia Tech Engineering Experiment Station.

RESEARCH IN THE TEXTILE INDUSTRY

Continued from Page 4

ever, textile research laboratories had become a recognized although still-small part of the industrial organization. The first World War served to reveal the marked deficiencies of textile research in this and other countries, and it was in an effort to overcome these deficiencies that research began to be practiced on the scale to which we have now become accustomed. Governments and corporations determined that they would never be caught unprepared because of lack of research. Even with this well planned program, much was frantically done toward the end of World War II which should have been ready at the beginning.

Dr. Vannevar Bush, in discussing textile research some 14 years ago, said in part: "In our modern tempo, that industry is in danger which is in a static state. Research, with its yield of new and better products, is not a luxury; it is a necessity, often as a defense against encroachment from without. The world in which we live is going to change, politically and sociologically no doubt, but also technically. We have no choice as to whether we will change with it; we simply have a choice as to whether or not we will change rapidly enough and sanely enough to remain a part of the essential scheme of things, or whether we will pass out of the picture."

This statement has proved to be true. Many industries have fallen by the wayside, while others have grown tremendously because they looked to the future and invested in research programs as safeguards. The phenomenal growth of the synthetic fiber industry is not an accident but is instead the results of many years of research and planning. Products emerging from research laboratories have been almost too numerous to mention. Such fibers as viscose, cellulose acetate, nylon, Vinyon, and Orlon

are largely reflections of the tremendous amount of research which has been carried out by the textile and chemical industries, working as a team. It is reported that one company has spent more than \$30,000,000 on rayon research alone. The success of rayon has encouraged other companies to adopt the rather generous policy of spending large sums of money for basic and fundamental research. Dr. Carother's discovery of the fiber-forming characteristics of linear superpolymers has spurred research men everywhere to investigate the fiber-making possibilities of a great number of polymers.

It is of particular interest to note the costs of research and development undertaken by the textile industry expressed in cents per sales dollar. The cotton industry spends 0.03 cents; the woolen industries 0.22 cents; and the rayon industry, 0.70 cents, compared to 1.16 cents for the research in the chemical industry.

RESEARCH GROUPS

Perhaps the oldest textile research organization in this country was the original U. S. Institute for Textile Research, founded in 1930. This organization later became the Textile Research Institute. Also founded in 1930 was the Textile Foundation, established by an Act of Congress with a fund of \$2,000,000 to engage in research for the textile industry. At the Institute's laboratories in Princeton, New Jersey, operated in conjunction with the Textile Foundation under a single technical director, fundamental research is being conducted on basic problems of wide interest to industry. Textile Foundation projects include studies of the mechanical properties and structures of fibers, yarns and fabrics; resilience; the effects of moisture adsorption; and the

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chemistry of starch and cellulose. The Textile Research Institute has been investigating cellulosic fiber damage, moisture meters, and some elements of warp sizing.

Incorporated at Charlottesville, Virginia, as a nonprofit educational institution in 1944, the Institute of Textile Technology serves as a graduate-level textile training school and also as a research center for supplementation of the research activities of individual companies. This latter program includes fundamental research by staff members; scientific studies by the students as part of their requirements for Masters' or Doctors' degrees; and investigations of specific problems presented by an individual mill, group of mills, or by an allied industry. Fields of investigation include the physical properties and chemistry of fibers, textile sizes, and finishes; tests and standards for textiles; and design and engineering for the development of new processes or equipment.

Textile research projects are also under study at such research organizations as the Georgia Tech Research Institute, the Southern Research Institute, the Mellon Institute, the Armour Research Foundation, the Industrial Research Institute of the University of Chattanooga, and the Midwest Research Institute. In addition, a certain amount of original investigation on problems of concern to the industry is being carried out at the various textile schools.

There are also a few commercial laboratories in this country with highly trained personnel and specialized equipment which are making worthwhile contributions to the industry's progress in scientific developments. Although a great number of textile products have come from industrial research laboratories, the development of others, such as wovenless fabrics, coiled-spring type yarns, and crease-resistant fabrics are the results of the research of the textile manufacturers themselves. More and more, manufacturers are recognizing the need for conducting their own research.

It is also noteworthy that the development of such industrial fabrics as nylon, Vinyon, and Orlon into useful articles such as chemical filter cloths, awnings, and acid- and alkali-resistant clothing could not have been successfully accomplished so quickly

after the yarns were made available without the application of real textile research by the textile manufacturers. Recognition should be given to the fact that these achievements have often been the result of close cooperation among the chemists and engineers of the chemical and "rayon" companies, the machinery manufacturers, the weaving technicians, and the sales departments of textile mills.

GEORGIA TECH RESEARCH

Since the Georgia Institute of Technology is located in a state whose chief industry is textiles, interest here in textile research seems perfectly natural. The A. French Textile School, from its first days, has always tried to serve the textile industry of this section by extensive cooperation, both by helping individuals to solve their local problems and by conducting a broad program of research on such phases as the flax and ramie investigations which will be discussed a little later.

The types of research which have been undertaken here have been both applied and fundamental. Studies have been made on the processing of both natural and synthetic fibers, even including work on the processing of rabbit hair.

In recent years, several research investigations have been conducted on various phases of cotton mill operations in order to effect new methods of increasing plant capacities and product quality. One such study was a comparison of the strength and evenness of yarns spun from the same grade of cotton but processed under varying conditions of settings and speeds on the picker and the card. The purpose of this investigation was the determination of the setting and speed of these machines and the amount of waste fabric from each by which maximum strength and uniformity of the yarn is obtained.

Another subject of study has been the effect of starch modification on the relative humidity necessary for weaving cotton fabrics. A completely air-conditioned room was employed, in which a wide range of temperatures and relative humidities could be maintained. Various starches were used as warp sizings for cotton warps of similar construction. Weaving tests were conducted

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under various temperatures and relative humidities. Much data were obtained which should be very useful to starch manufacturers and to textile mills weaving cotton fabrics.

Some of the early work on the use of pine pulp as a source of raw material for the production of rayon was conducted at Georgia Tech. Comparison studies were also made with spruce and cotton pulp. These experiments clearly demonstrated that sulfite pulp from Southern pine was a satisfactory material for the production of viscose rayon. Rayon production in general has increased tremendously in recent years, and it is probable that different raw materials than those used at present will have to be increasingly employed. In this light, Georgia Tech's viscose rayon research takes on added significance.

FLAX RESEARCH

The most extensive textile research program undertaken here at Georgia Tech involved the processing of the bast fibers; namely, flax and ramie. In 1937, the Georgia Tech Engineering Experiment Station, in cooperation with A. French Textile School, inaugurated a research program on the processing and utilization of domestic flax, sponsored by the Tennessee Valley Authority. The initial objectives of this project were the development of methods and equipment for mechanically decorticating and chemically degumming flax to produce a stapled fiber which could be processed on cotton mill machinery. The goal was the production of an inexpensive flax fiber which, alone or in admixture with cotton or other fibers, could be used to produce fabrics of different types. Although the project's objectives were modified later, results obtained justified the original goal. Many types of decorticating and degumming equipment were designed and discarded before a pilot plant was constructed. Large quantities of domestic flax straw were processed into usable fiber, which was further processed into yarns and fabrics. In addition, suitable quantities of flax fiber were furnished to several textile mills for use on a commercial basis.

The results of these investigations showed that flax fibers and fabrics can be produced

on a commercial scale by methods developed at Georgia Tech. Reports published on this work have been supplied to many organizations and persons who have been interested in the processing of flax by this method.

RAMIE RESEARCH

As a direct result of the research on flax, a similar research program was inaugurated in 1945, for a private sponsor, on the processing of ramie fiber, or "China grass," into yarns, fabrics, and other products. This program required approximately three years and the expenditure of some \$75,000.

Ramie fiber has long been a subject for enthusiastic predictions, few if any of which have been realized. As a consequence, much has been written about the great advantages that ramie fiber possesses over most of the other fibers as regards tensile strength, luster, resistance to rot and mildew, high absorbency, rapidity of drying, and great increase in tensile strength when wet. On the other hand, the literature also includes mention of such disadvantageous properties as stiffness and lack of toughness.

Very little information, however, has been published on the merits or demerits of ramie when made into textile products on modern systems of textile processing such as those used in this country today. The primary intent of the Georgia Tech investigation was the examination of ramie fiber properties in order to determine whether economical and practical methods could be developed to process ramie fibers into textile products, and to indicate to what extent the fiber properties affect the ultimate quality of these products when manufactured on modern systems of textile processing.

Processes required to extract the ramie fibers from the stems of the ramie plants are quite similar to those used in obtaining flax fibers from flax straw; i.e., decortication (removal of the bark and core of the stem), degumming, washing, drying, and opening, followed by processing on regular or modified textile equipment.

Ramie in the form of decorticated ribbons from a variety of sources was obtained and examined during this investigation. Bales were obtained from the Philippines,

Sumatra, Brazil, West Africa, Haiti, Cuba, and Florida. The decorticated ribbons were from four to six feet long. These were usually cut to the desired fiber length before chemical degumming.

Degumming has been referred to in the literature as one of the chief problems confronting the commercial utilization of ramie fiber. Hundreds of degumming procedures have been reported. Some of the most promising of these and many other original procedures were tried here, and the results obtained indicated that properly decorticated ramie fiber may be satisfactorily degummed by use of any one of several different chemical processes. Very good results were obtained by employing various wetting agents, soaps, alkalis, and acids, followed by the applications of suitable finishing or softening agents. The degummed fibers were washed free of chemicals and then dried, after which they were opened by passing them through a garnett card.

At this stage, the fiber was in the same physical condition as cotton fibers from the cotton gin. The steps employed for making the ramie fiber into yarns, with a few exceptions, were quite similar to those used for processing stapled rayon and cotton. In fact, most of the ramie yarns and fabrics on which tests were made were produced on the cotton system. Laboratory spinning experiments were supplemented by actual cotton mill processing on a small scale. The weaving of the yarns spun during these experiments was done on conventional equipment. In order to obtain materials for properly comparing ramie with linen and cotton, the design and construction of most of the ramie fabrics were limited to types commonly found on the market for linen and cotton.

Finishing and dyeing methods commonly used for cotton and linen were found to be suitable for ramie. However, it was noted that some direct and vat dyes had difficulty in penetrating the yarn and that the time of dyeing had to be increased to obtain the desired shade. Package dyeing of yarns proved to be very successful.

Mercerization of yarns and fabrics increased the affinity of the fiber for the dye-

stuff and improved the natural luster of the fiber.

Although emphasis was placed here on fabricating materials for use in the testing and analysis program, some efforts were made to produce fabrics which could be used to evaluate the properties of the finished article or garment from a consumer's standpoint. These fabrics were given various commercial finishing treatments, depending upon the end use, and were then made into kitchen towels, summer wearing apparel, table fabrics, draperies, and upholstery material. The field of industrial products was also explored to some extent. Important among the products studied were packing, a heavy canvas of interest to the Navy, braided wire coverings, narrow tapes, and marine cordage.

These studies indicated that the high tensile strength characteristic of ramie refers to the fiber itself since, in the specific yarns and fabrics tested, the potential superiority in strength of the fiber was not realized. It was also shown that brittleness is not an inherent characteristic of ramie, as commonly believed, but is largely controlled by the type of degumming and finishing treatments given to the fiber.

In comparing the appearance and "hand" of the light-weight fabrics made during this study, ramie showed a more definite resemblance to linen than to cotton. Tests on the specific yarns and fabrics examined showed that the ramie was superior to both the linen and cotton: (1) in resistance to flexing and to residual shrinkage during repeated launderings, (2) in tearing strength and bursting strength, and (3) in tensile strength when wet. It was also superior to linen in resistance to mildew and in loss of strength due to laundering, and it was superior to cotton in both the dry and wet strength of yarns of three ply or greater. In a coolness test on comparable fabrics, the ramie fabric was slightly cooler than the cotton. Ramie fabrics tested demonstrated excellent resistance to deterioration caused by folding and creasing.

On the basis of a balance of properties reported, it appears evident that in those special fields which demand a premium in appearance or serviceability, all-ramie fabrics should be attractive and desirable.

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FUTURE TEXTILE RESEARCH

Pure science shows how molecules may be combined to build high polymeric substances. Fundamental research builds a filament, on the one hand hand, or a resin, on the other. Applied research shows how to coat or penetrate the fiber with the resin, as the case may be, and thus how to create a better textile material. In the past, little did the pure scientist studying organic valences "with wrinkled brow" realize that fundamental and applied research based on his work would eliminate wrinkles in milady's fabrics.

The place of research in the textile industry is by now an assured one, a role in which textile engineers, chemists, physicists, and others will join in the solution of problems, in the advancement of knowledge, and in the production of new and improved products. Exactly what the future holds is, of course, anyone's guess.

In an "applied" field of science such as is most textile research, it is important for us to remember that it is the end-use of the products of such research that "really count." Based on past research results, one may anticipate that the future will see new and improved methods of processing natural and man-made fibers, as a result either of fiber modifications or the improvement of mechanical processing for preparing yarns and weaving fabrics. New uses will be developed for old fibers, and new fibers will be discovered to meet old needs and to inspire new applications.

Industry is constantly faced with three age-old problems as regards its products—how to make them better, how to make them cheaper, or how to produce something entirely novel. Research is the tool which must be employed to attain the desired goals.

SEPARATION OF RARE EARTH ELEMENTS

Continued from Page 10

gave no precipitate with oxalic acid solution. The eluting solution was passed through the column at a flow rate of 15 ml./min. The effluent was caught in fractions having a volume of 1000 ± 100 ml.

The rare earths present in each fraction were precipitated by adding 20-40 ml. of saturated oxalic acid solution. After standing overnight, the oxalate precipitate was removed, ignited for 8-14 hours at 800-850° C. in a muffle furnace, and weighed as the oxide. The oxide was analyzed spectrophotometrically for neodymium and praseodymium by means of a Beckman Model DU quartz spectrophotometer equipped with quartz cells having a one centimeter optical path. The neodymium bands at 794 and 739 millimicrons and the praseodymium band at 444 millimicrons were employed in these analyses, as well as for the analysis of the starting material. Analyses were carried out on solutions made by dissolving 90 to 130 mg. of oxide in 2 ml. of 2 M HCl and diluting to 10 ml. The spectrophotometer was calibrated by using dilute chloride solu-

tions made from oxides of high purity obtained from Jarrell-Ash Company, Boston, Massachusetts. The neodymium oxide (Adam Hilger, Ltd., Lab. No. 6783) was described as being 99.75 per cent pure. The praseodymium oxide, Pr_2O_3 (Johnson, Matthey, and Co., Ltd., Lab. No. 1533) was described as being of high purity. Independent spectrographic analyses using the copper spark method,¹³ together with comparison of the spectra of these materials with those obtained from oxides prepared in later ion exchange separations carried out in this laboratory, have confirmed the general correctness of these descriptions.

Reference to Figure 2 shows that the neodymium and praseodymium elution bands were not completely resolved in this experiment, while the lanthanum band was completely resolved from the praseodymium band, at least in the sense that no oxalate precipitate appeared in Fractions 34 through 36. Beginning with Fraction 36, the pH of the eluant solution was increased to 3.60, whereupon the lanthanum was rapidly re-

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moved from the column. These results are in agreement, where comparison is possible, with those reported by Harris and Tompkins.¹⁰

Table I summarizes the recovery of the various oxides.

TABLE I
RECOVERY OF RARE EARTH OXIDES

	Nd ₂ O ₃ gm.	Pr ₆ O ₁₁ gm.	La ₂ O ₃ gm.	Total gm.
Input ^a	1.81	8.54	9.65*	20.00
Found by analysis	1.77	8.50		
Weight of fraction			9.14	19.56
Per cent recovery	97.8	99.4	95.7	97.8

*By difference.

Analyses of Fractions 23 through 28 showed that 6.34 gm. (74 per cent of the total Pr₆O₁₁ present in the starting material) was recovered as Pr₆O₁₁ having a purity of 98.3 per cent. The Nd₂O₃ content of Fractions 26 through 29 was one per cent or less, very near the limit of the reproducibil-

ity of the spectrophotometer (about 0.5 per cent).

The praseodymium oxide obtained in Fractions 23 through 30 of Run No. 3, together with some praseodymium oxide obtained in a similar, though smaller, scale experiment, was further purified by elution with 4.4 per cent citric acid of pH 3.05. A lower pH was employed in this experiment (designated as Run No. 4) in order to obtain a better separation between neodymium and praseodymium.¹⁰ The starting mixture consisted of 5.849 gm. of an oxide having the composition: 1.5 per cent Nd₂O₃ and 98.5 per cent Pr₆O₁₁. The column used contained Dowex-50 resin (60-80 mesh) in the acid form. The resin bed was 2.1 cm. in diameter and 81 cm. long. Elution was carried out at a flow rate of about 1.4 ml. per min. per cm.² of column cross-sectional area, the effluent being caught in fractions of about 460 ml. each.

Figure 3 gives a summary of the results obtained. Spectrophotometric analyses for neodymium and praseodymium were carried out on Fractions 16 through 29. These

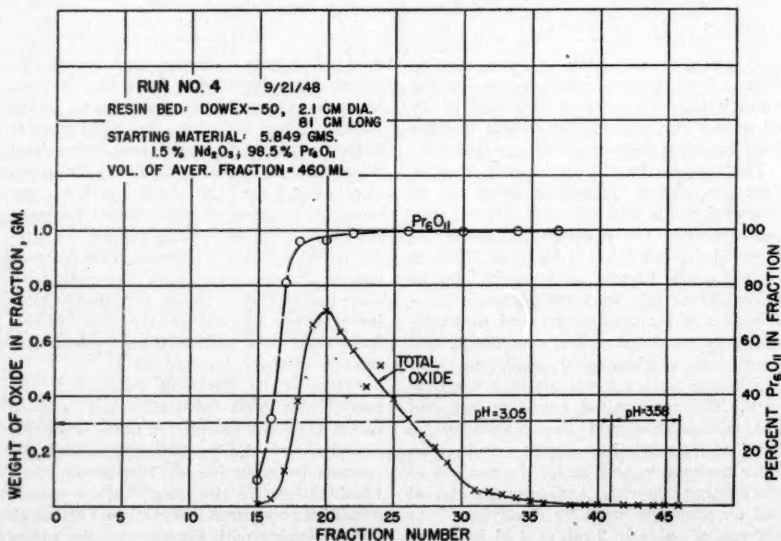


Figure 3. Data from the further ion exchange purification of the 98.5 per cent Pr₆O₁₁ obtained from Run No. 3 (Figure 2) and a similar run.

analyses showed that 98.6 per cent of all the Nd_2O_3 originally present was contained in Fractions 15 through 21, while Fractions 22 through 29 contained no detectable amount of neodymium. These results suggest that Fractions 22 through 29 (and very probably Fractions 30 through 38 as well) consist of Pr_6O_{11} having a purity estimated to be 99.8 per cent or better.

No significant difference was found between the spark spectrum of an HCl solution of the oxide obtained in Fraction 26 and that of an HCl solution of the oxide used as the reference for calibration of the spectrophotometer.

A number of additional experiments have been carried out with starting mixtures having compositions similar to that employed in Run No. 3. These experiments have been made using "5%" citric acid (900 gm. of citric acid monohydrate instead of 800 gm. per 18 liters of water) having a pH range of 3.11 to 3.15 and starting oxide weights ranging from 19.3 to 31.0 gm. In all but one of these experiments, the Dowex-50 resin was in the acid form. The flow rate employed was 1.1 ml. per minute per cm^2 of column cross-sectional area.

In these later experiments, neodymium first appeared in the effluent after the 15th (± 2) liter of citric acid had passed through the column. The resolution of the praseodymium and neodymium bands was considerably greater, the rising front of the praseodymium band beginning, in general, after the neodymium concentration in the effluent had fallen to about one half of its peak value. This minimum occurred at about the 22nd liter.

Few analyses were made of the fractions obtained in these later runs. However, the blue-to-gray color of the oxides from the first few fractions of the elution, together with their known weights and the known analysis of the starting mixture, suggest that the purity of the major Pr_6O_{11} fractions is about the same results given in Figure 2, even when 30 gm. of starting material was used.

One further experiment similar to that described in Run No. 4 has been carried out using a column 4.7 cm. in diameter and 75 cm. long. The starting mixture consisted of 16.28 gm. of an oxide having the

approximate composition 99 per cent Pr_6O_{11} , 1 per cent Nd_2O_3 . This experiment (Run No. 11) was performed with the resin in the ammonium form, using "5%" citric acid of pH 3.01 and a flow rate of 1.1 ml. per minute per cm^2 cross-sectional area of column. Spectrographic and spectrophotometric analysis indicated that at least 12.9 gm. of Pr_6O_{11} having a purity of 99.8 per cent was obtained.

ACKNOWLEDGMENT

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thus amplified both the horizontal deflection voltage and the video voltages, thereby eliminating the necessity of separate video and deflection stages in the monitor.

CONCLUSIONS

Velocity television reproduction is capable of reproducing printed material and line drawings with acceptable legibility, although it does not achieve the fine contrast gradation produced by conventional television systems. For specific industrial and military applications, VTR may offer some advantages because of its unique presentation of the subject matter. In addition, the possibility of circuit economy should be considered, since it appears that velocity reproduction can be achieved with fewer electron tubes in the kinescope circuit than are required by conventional monitors and receivers.

The prime importance of this investigation of velocity modulation may lie in the fact that it indicates a type of picture distortion which may arise in standard commercial video systems. Spurious coupling

between the video channel and the deflection channels of television receivers or cameras will result in a halo effect similar to that caused by "overshoot," or in some other form of distortion. On the other hand, a proper combination of VTR with an intensity-modulation television system may produce an improvement in the effective resolution of the television system.

The full implications of this hybrid method of television reproduction are not completely apparent at this date. Research now in progress at Georgia Tech on the VTR system and its allied aspects may bring forth additional significant results.

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DIGESTS OF GRADUATE THESES

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consuming and wasteful of materials, the object of this research was to study the applicability of the technique of ion exchange to the separation of these two metals and to prepare scandium of spectrographic purity.

Discussions in this thesis include results of the search for sources of scandium salts and minerals, some of the history and chemistry of scandium, work on the quantitative analysis for the cations, and ion exchange column experiments. These experiments point out several of the factors involved in the separation of scandium and thorium by ion exchange resin columns, describing many of the experimental results achieved by methods that may introduce considerable error. Results showed that the scandium recovery from a citric acid solution by precipitation as the oxalate is not so great as the recovery of thorium or of the rare earths by the same method. Separation of scandium from thorium may be achieved with an ion exchange column and citric acid eluant, and thorium, according to theory, should be eluted first from the col-

umn because it is relatively less basic than scandium. A. S. C.

Max Allen Turner, *The Separation of Samarium from Rare Earth Mixtures by Means of Ion Exchange*. Faculty advisor: Dr. W. T. Ziegler.

The use of ion exchange processes for the separation of the rare earths has been developed during recent years in connection with the separation of rare earths resulting as products of uranium fission in the atomic pile. Basing the study on published reports of such work, it was proposed to investigate further the possibility of preparing pure samarium oxide by the ion exchange method alone. Of the several variables affecting the process, the effect of varying the pH of the complexing agent was chosen for study, other variables being fixed, and purification was checked by means of the adsorption spectra.

From this work, it was found that all rare earths other than gadolinium and possibly europium are readily removed from samarium by means of the ion exchange method. However, it was evident that separation of gadolinium from samarium by

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variation of pH alone cannot be achieved without several repetitions of the process on the richer fractions. *A. S. C.*

CHEMISTRY

William Stewart Johnson, *The Determination of Nitrates in Polluted Stream and Sewage Samples with Brucine Sulfate Using the Brucine Technique*. Faculty advisor: Dr. Robert S. Ingols.

The two present approved methods for the determination of the nitrate ion concentration of water and sewage samples, the phenoldisulfonic acid test and reduction followed by Nesslerization, are both too time consuming. The investigation reported in this thesis was conducted in an attempt to employ a brucine sulfate reagent for the determination of nitrate ions by investigating the reproducibility of results obtained in the presence of the various ions normally found in water and organic wastes, along with applicability to polluted streams and treated sewage samples.

The colorimetric procedure evolved for the determination of nitrate ions involves addition of a solution of brucine sulfate in ethyl alcohol and water to the sample, followed by the addition of concentrated sulfuric acid. The reagent and the color developed were not as stable as in the standard phenoldisulfonic acid method, and, in concentrations of the nitrate ion above 10 p.p.m., dilution of the sample before color development was necessary. Results are comparable to those of the phenoldisulfonic acid technique, particularly between about 0.7-2.0 p.p.m. nitrate ion concentration. Organic matter, including carbohydrates and various ions normally present in streams and sewage, does not interfere within the limits investigated. Procedure time was less than in the present approved techniques because evaporation to dryness was not necessary. Ten determinations were completed in less than one hour with brucine sulfate. Sample size was reduced from 100 ml. to five ml. *A. S. C.*

George Wilse Robinson III, *The Absorption Spectrum of Ozone in Solution*. Faculty advisor: Dr. W. H. Eberhardt.

Despite extensive work on the spectrum of gaseous ozone interpretation of the spectrum in terms of the structure of the molecule is somewhat obscure and in disagree-

ment among different investigators. Since the decomposition rate of ozone in certain solutions is different from that in the gas, it was proposed in this thesis that an investigation of the spectrum in solution might disclose facts related to the structure of the molecule and the spectrum in general, as well as information on the decomposition mechanism.

Investigation of the absorption coefficients of ozone in carbon tetrachloride in the region 4500 Å—6400 Å (both photographically and photometrically) are described, as are the construction and use in the preparation of solutions of an ozonizer of novel design. The absorption contours of ozone in carbon tetrachloride were found to be equivalent to those of the gas, while the absorption coefficients were increased by a factor of five. The absorption contours of ozone in water were found to be quite different from those of the gas, because of an increased intensity of one of the transitions with respect to the other. It is thought that the geometry of the molecule in the excited states is such that one transition becomes more probable than the other in the presence of a strong dipole. *A. S. C.*

Averal Theodore Trimble, Jr., *The Catalytic Hydrogenation of Quinoline*. Faculty advisor: Dr. J. A. Stanfield.

The study reported in this thesis was concerned with the catalytic hydrogenation of the quinoline molecule, which contains the benzene and pyridine rings, on which previous hydrogenation studies have been conducted.

Following an analysis of the theoretical factors involved, experiments were conducted in a modified standard low-pressure hydrogenation apparatus under defined standard conditions, and graphs were drawn for the determination of standard reaction rate constants. The effect of temperature, the nature and amount of catalyst, and the nature and amount of quinoline were studied. Data obtained for the hydrogenation of quinoline to tetrahydroquinoline gave evidence that hydrogen apparently is adsorbed so much more rapidly upon the catalyst surface than is quinoline that the latter is given little or no opportunity to approach the bare catalyst. *M. M.*

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Frederick Samuel Wilson. *A Study of the Effect of Pressure on the Visible Spectrum of Ozone*. Faculty advisor: Dr. W. H. Eberhardt.

The absorption spectrum of ozone in the visible region consists of a number of rather diffuse maxima which under ordinary conditions exhibit no fine structure, and these bands have been found to exhibit a pronounced pressure or solvent sensitivity at high pressures of admixed gas or solvent. This region of the spectrum has heretofore been investigated only by use of rather dilute mixtures of ozone in oxygen, and the several investigators have obtained results which in some respects vary quite considerably.

The purpose of this work was to obtain an accurate graph of the molar extinction coefficients of ozone in the visible region by use of pure ozone, in order to replace the rather questionable curves derived from

work done on dilute mixtures. It was also desired to investigate the possibility that under favorable conditions of low pressure and long optical path; the maxima in the visible region might be resolved into fine structure. However, no fine structure was observable using a 17-meter cell at one millimeter pressure. The effect on the absorption spectrum caused by the addition of various low pressures of seven different gases was studied, and it was attempted to correlate these results with the pressure effect at high pressures. The effect caused by foreign gases was found to be a combination of at least two factors: a pressure effect and a dipole force-field effect. In general, the effect of the foreign gas on the spectrum of ozone was found to be least at about 6000 angstroms, increasing with increasing distance from this region. A. S. C.

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ments. Considerable use of its facilities in applied research for the textile industry is anticipated by the Textile School.

Change is inevitable in any industry and particularly so in one in which multitudinous raw materials (different fibers and different treatments) compete for given uses and seek to create new demands. Change cannot come without research to provide the means, however, and it is here that such research laboratories as those at Georgia Tech can serve very definite functions.

